DATE: 4/01/97

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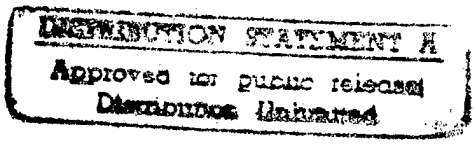
DISTRIBUTION STATEMENT A: Public release



The following article from the May-June 1996 issue brings readers up to date on the past developmental history of the M1 Abrams tank series, and outlines plans for future improvements.

The M1A2: Current and Future Program Plans

by Wes Glasgow, Colonel Christopher Cardine, and David Latson

(May-June 1996)

The M1A2 main battle tank, the latest product-improved version of the Army's premier ground combat system, is at the forefront of the Army's modernization efforts. Such planning is imperative, especially in today's era of diminished funding for research and development of completely new systems. This reality, and the uncertain state of the Threat, means that the M1-series tanks may very well equip the majority of the Army's armor and armored cavalry units well into the 21st century.

The perception of a reduced foreign tank threat makes it difficult to justify a completely new tank system anytime soon. Thus, a prudent course in light of this situation -- and given likely upgrades of foreign tanks with current technology and their sales to potential threat nations -- is to plan for uncertainty and maximize options by upgrading the existing M1 fleet. This will both improve a known high capability and leverage the soldier's trust and familiarity with a proven operational system.

This article provides a view of the M1 modernization program by sketching its progress, giving an overview of the M1A2 (the vehicle currently being fielded), detailing plans for a bold System Enhancement Program (SEP) product improvement, and providing forecasts for even further upgrades, all designed to integrate the latest technologies. The chief goal is to ensure the M1 overmatches all possible threat vehicles, thereby maximizing our soldiers' chances for victory in the future.

Progress

The M1 tank, entered service in the early 1980s, the first successful U.S. tank development program since the late 1950s. It represented a dramatic advance over the M60-series tanks which, throughout the 1960s and 70s, had been seriously overmatched by Threat vehicles like the Soviet T-64 and T-72. Although durable, lethal, and battle-proven in the Arab-Israeli Wars of 1967 and 1973, the M60 was vulnerable to antitank guided missiles (ATGM) -- including those carried by infantrymen -- as well as conventional tank and antitank gun kinetic energy (KE) threats.

During M1 Abrams development, the predominant design priority was crew survivability. The design countered the Threat by providing the soldier with significant improvements in armor protection, crew survivability, fire control, and mobility. Its most significant single enhancement, special armor that was effective against both KE and chemical energy (CE) rounds, provided excellent protection against many Threat direct fire weapons at various angles and ranges. Throughout the program, the development of the armor package has proceeded apart from the tank itself, and later incremental improvements in armor and suspension were added to the last few vehicles of the M1 production run, which became known as the Improved M1 or simply the IPM1.
The first major vehicle block product upgrade, the M1A1, added a more powerful weapon system, the 120mm M256 smoothbore cannon, again improved the armor package, added an on-board positive pressure NBC system, and included a more durable track. The M1A1, produced in greater quantities than any other variant of the M1 series, equips the majority of the fielded U.S. armor and armored cavalry units. It is the tank equipping the armor units that deployed to the NATO peacekeeping mission in Bosnia.

The second major block product upgrade, designated the M1A2, represents a significant technological shift. It incorporates a massive investment in digitization in its on-board systems, all aimed at improving the reliability, fightability, and operational capability of the tank. Reliability is improved through the use of integrated circuits and greater reliance on built-in diagnostic capabilities. Operations and fightability are enhanced through advances in battle management, fire control, survivability, maintainability, and supportability. The M1A2 is beginning its fielding now, and will principally equip the highest priority

supportability. The M1A2 is beginning its fielding now, and will principally equip the highest priority armored units worldwide.

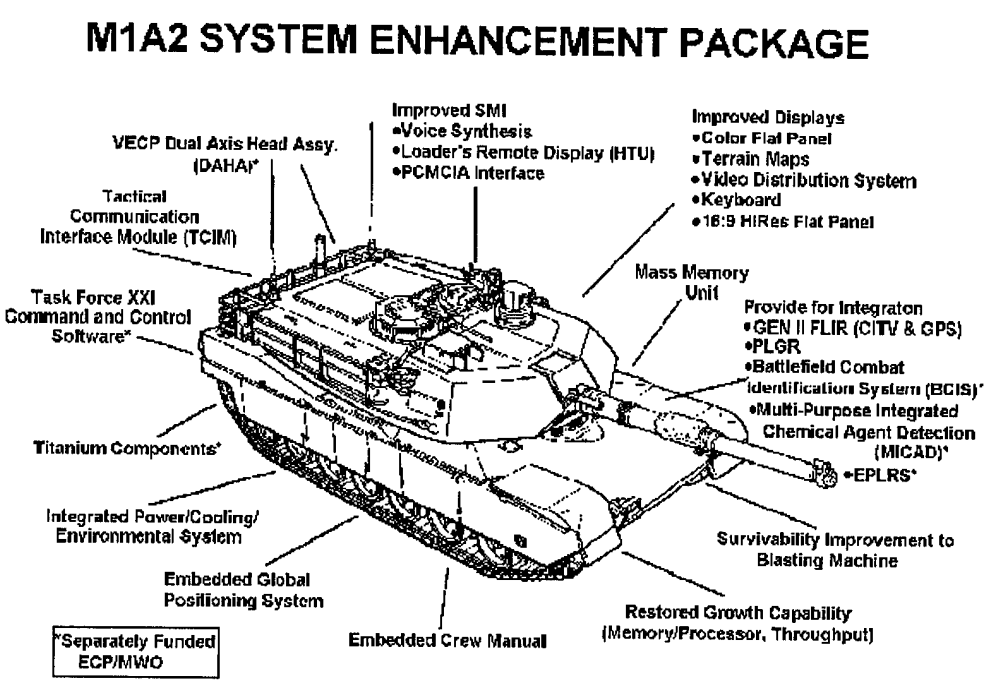


Figure 2

M1A2 Highlights

The M1A2 represents a major technological advance, due to its extensive use of digital electronics and microprocessor control. The core electronic architecture of the system is the backbone of the tank. The system utilizes a high-speed MIL-STD-1553B data bus with a sophisticated system integration package for transmitting digital information and commands throughout the tank. Electronic sensors and systems improve driving, target identification, and information flow between the computer-driven subsystems and the crew, as well as with the Inter-Vehicular Information System (IVIS) that links tanks and other combat elements. The commander, gunner, and driver have new displays. The scope of these changes is remarkable when one realizes that, in the previous generation M1A1, the Army has a tank that is about 10% digital and 90% analog. With the M1A2, the proportion is reversed, with 90% being digital and only about 10% analog.

Lethality and fightability are improved with enhancements to target acquisition and fire control. The Commander's Independent Thermal Viewer (CITV) gives him a 360-degree, all-weather, day-night, target surveillance system that allows the commander and gunner to act as a "hunter-killer" team. The commander searches for targets while the gunner engages a completely separate target. When the gunner fires the weapon, the commander can then "hand-off" a new target to the gunner with the push of a button. This capability greatly enhances the potential lethality of the system and measurably improves the engagement speed of the tank, getting multiple, accurate rounds down range. This is often the most critical factor in tank survivability on the battlefield.

The IVIS capability dramatically improves command and control in battle situations. The IVIS processes key information at the commander's control through an integrated, gridded mapping system of the area of operations. The IVIS displays the locations of enemy and friendly vehicles, displays selected transmitted reports, and provides current status and diagnostics of key systems. These features alleviate some tiresome administrative tasks, while enabling vehicle and force commanders to better understand the battlefield situation. Knowledge of the precise status of friendly and enemy units will significantly aid the commander's ability to make rapid and correct tactical decisions.

IVIS is augmented by a Position Navigation (POS/NAV) system which, through the Commander's and Driver's Integrated Displays (CID and DID), displays vehicle position and heading references to both the commander and driver. The CID reduces the commander's previously burdensome and time-consuming navigational tasks and greatly improves overall situational awareness. For the driver, this capability enables him to move from point to point on the battlefield without constant direction from the commander, while the system's all-weather capability allows him to concentrate on correct tactical movements without constant reference to maps or key terrain features.

Improved weapons sights and stations also enhance survivability. The gunner's sight includes azimuth stabilization. The dual-axis stabilization greatly enhances target acquisition and target tracking functions, especially while on the move. The Commander's Independent Thermal Viewer increases his field of view to a nearly continuous 360 degrees to aid in target detection. Improved sight armor enhances survivability of these critical components. Other survivability advances include redundancy of electronic processors in the hull and turret and the dual redundant 1553 and 485 data/utility busses.

Supportability enhancements stem principally from the high commonality of components in the core electronics system. The extensive collection of Simplified Test Equipment (STE) required for the M1A1's on-vehicle diagnostics has been eliminated by built-in test and diagnostics capabilities. The software not only enables the crew to determine and isolate faults, but can automatically reconfigure the hardware to give the crew the highest level of residual functionality possible in light of the fault conditions. The crew and mechanics can initiate fault isolation tests to isolate faulty Line Replaceable Units (LRUs) so as to permit rapid repair by component replacement, and restoration to battle-ready condition.

Additional improvements have been added for special purposes and/or in support of export/joint vehicle programs. For example, a Mine Clearing Blade System can provide rapid and independent breach of simple minefields. For export to the Kingdom of Saudi Arabia and Kuwait, the tanks include slight modifications to their core electronics to interface with compatible intercom and radio systems in those armed forces. Additionally, the Saudi and Kuwaiti M1A2s are dual-language capable and display all information in either English or Arabic.

The M1A2 represents a major success as an acquisition program, especially so with respect to the major improvement in digitization. What other program, especially one as revolutionary as the M1A2, can boast of a Milestone II decision in December 1988 with a first prototype delivered in 1992, an Initial Operational Test and Experimentation (IOTE) in 1993, a MS III decision in April 1994, and a First Unit Equipped in 1995? These accomplishments are especially significant since the tank is the flagship ground digital platform and has also been represented in nearly every Army Warfighting Experiment (AWE) to date.

Overall, the M1A2 improvements provide a radical change in capability and present a unique opportunity. The digital capability enhances the vehicle's performance on the battlefield to permit it to overmatch any known comparable tank, both operationally with respect to situational awareness, and tactically with respect to lethality and performance. However, the potentiality for future growth holds even greater promise. The M1A2 user community and project office will begin to exploit this potential capability through implementation of the M1A2 System Enhancement Program (SEP).

M1A2 SEP Overview

The M1A2 SEP was a direct outgrowth of discussions and plans at the M1A2 Milestone III review in April 1994 to keep the M1A2 in step with a heavy emphasis on digitization experiments under the AWE or Force XXI. These concepts are designed to mold Army doctrine and modernization toward the vision of a future digitized battlefield. Additionally, the constant advance of both microprocessor and memory capacity require regular computer hardware upgrades.

The SEP improvements focus on modifications to the computer core that are necessary to accept Army command and control software and operating standards, also known as the Common Operating Environment (COE). Yet they will have minimal impact on intra-vehicle software and standards which run individual vehicle components. These intra-vehicle systems should infrequently require new

run individual vehicle components. These intra-vehicle systems should infrequently require new software code, certainly less often than the Command and Control or COE software. The improvements involve both extensive hardware and software enhancements **(see Figure).**

The most significant hardware improvements include the second-generation Forward Looking Infrared (FLIR) in both sights, the Enhanced Position Locating Reporting System (EPLRS), a Global Positioning System (GPS) to enhance the positioning and navigation (POS/NAV) system, an integrated under-armor power/cooling system to mitigate power consumption and electronics heat, enhanced memory and display components, and interfaces for the separately developed Battlefield Combat Identification System (BCIS), and Multi-Purpose Integrated Chemical Agent Detector (MICAD).

The major objective, however, is to provide for the assimilation of future electronic upgrades, including the Army's objective digitized command and control software COE. The SEP program will prepare for the acceptance of the Force XXI Battle Command Brigade and Below (FBCB2) software by incorporating better data processors, more memory capacity, better soldier-machine interfaces with adequate backup power, and cooling capability. The SEP allows for acceptance of that portion of the COE that affects inter-vehicle or inter-platform operations. The operations that affect only the activities within the internal vehicle systems can be carried on separately. This concept, a form of distributed architecture, is a critical feature in holding cost and complexity down. It means that software development of internal systems which, once proven, will remain relatively robust. The architecture will be less affected, if at all, by different versions of inter-vehicle software, which will frequently change as new functionality and coordination is desired between vehicles and combat elements of the force.

The Under Armor Auxiliary Power Unit (UAAPU) is a key SEP component because of the power requirements of digitization. When the main engine is shut down, these new functions will require more power than can be sustained for long using on-board batteries. The UAAPU will provide electrical power during silent watch and will recharge the vehicle batteries with the engine shut down. The system can bleed air to the NBC overpressure system and will reduce the main engine operating hours and associated high fuel consumption. This will yield savings in operations costs and reduce engine wear and fuel consumption while increasing net operational range. It also provides power for the electronics cooling unit which reduces heat in the crew compartment, thus increasing electronic module reliability.

The second-generation FLIR system enhances the capability and reliability of the M1A2 in night and reduced visibility. In addition to improved visibility, the SEP/second-generation FLIR will upgrade and replace current hardware and software.

The current plan is to produce and test prototype tanks with SEP equipment installed. Upon approval, the entire fleet of 1,079 M1A2s will be fitted with the SEP equipment. A production Engineering Change Proposal (ECP) will be implemented for those tanks produced after FY 1999. Beginning in 2000, the retrofitting of already fielded M1A2s via a Modification Work Order (MWO) will start.

The M1A2 SEP program does not exhaust the planned improvements that are available to keep the M1A2 current. Pre-Planned Product Improvements (P3I) further enhance the tank, but loom farther out on the horizon past the final application of the SEP improvements. However, there is currently no funding in the Abrams program for product improvements beyond the SEP).

Most of the additional improvements involve more advanced technologies, such as: digital processing of the second-generation FLIR sensor data for advanced functions (auto target tracking, target recognition, cueing, etc.), embedded training, helmet-mounted heads-up displays, and an integrated combat protection systems designed to automatically counter incoming threat projectiles and missiles.

Several of these refinements and technologies may mature early and be funded as a future P3I ECP/MWO within the production run of the M1A2. The key is that the bulk of the electrical and computational power and interface requirements will have already been built into the tank as a part of the SEP improvements and can help smooth the integration of these items.

The M1A2 P3I program will remain in a good position to maximize the digitization developments that

are the outgrowth of the Army Warfighting Experiments. The key is an architecture that is rapidly adaptable to changing requirements, Threat capabilities, and emerging technologies. The M1A2 is just such a system, and is designed to leverage and interface with the other members of the combined arms team. As the foremost digital platform, the M1A2 will continue to lead the digitization effort through application of technology and will practically demonstrate which digital revolutionary concepts are doable.

The Future

The M1A2 will be the Army's premier combat fighting vehicle through the foreseeable future. It is, and will remain, the only digital weapons platform that can survive on the close combat battlefield. Funding realities and the force structure, however, will dictate that not all units will receive the M1A2, nor will it be beneficial to do so, since many units will remain in the force structure that are not digitized or are equipped with a range of less integrated digital appliqué elements. Units below Force Package I will predominantly continue to be equipped with the M1A1; however, even some M1s will remain.

Once systems are fielded, however, the story does not end. The Abrams Integrated Management XXI (AIM XXI) program is designed to maximize efficiencies through teaming of government and industry agencies to perform intensive management based upon their core competencies. The team will evaluate every facet of the program to sustain the fleet at minimal costs, while seizing opportunities to reduce management overhead and attaining operations and support cost reductions through component and process re-engineering.
The story of digitization will ultimately be developed by soldiers who will live, breathe and function digitally on the battlefield, both in warfighting experiments and day-to-day operation. The daunting challenge is to provide the facilities to undertake and support that capability so that the soldier can stretch his imagination to take digital doctrine and tactics to the highest levels of performance and, over time, develop the real potential of this new technology.

The tactical level of war in the digital environment promises a tremendous payoff in speed, battlefield dynamics, and flexibility. This promise is achievable only by freeing the soldier of routine, non-critical tasks and allowing him to focus on the tasks that are critical for success.

The digital applications and subsystems on the M1A2 are true pathfinders in these areas. The soldier will determine the true worth and utility of digitized operations and will find the things no one has thought of before. Those results may lead Army efforts in completely new and uncharted directions. The M1A2 program is ready to make those adjustments with a dynamic architecture that is structured for change.

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09 May 1996/FDC
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